Diversity of Nanocrystal Shape and Morphology: A Brief Review

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During recent years the science and technology of nanosized crystals advanced rapidly. This progress became possible by dint of development of electron microscopic techniques enabling the visualisation of an individual nanocrystals. One of fascinating opportunities in this field are the growth techniques permitting for the control of the nanocrystal shape. The nanocrystal shape is an important feature as it influences the physicochemical properties of the material. A large free surface is a shape-dependent factor deciding about the applicability of the nanostructure as catalysts or sensor. A valuable recent development is the synthesis of low-density architectures can be designed for construction of ultralight alloys [1].

The diversity of already reported geometrical nanocrystal forms is quite large. Many techniques of nanocrystal synthesis and growth are known such as hydrothermal route, sputtering, epitaxy. New methods are under development, one of them enables production of metallic and oxide nanoparticles in an original way, namely with a contribution of microbes [2]. They provide nanoparticles of irregular as well as regular shapes. The nanocrystal form and morphology can be controlled through choice of reaction parameters (see e.g. ref. [3,4]), by tuning the fluid composition in the supercritical fluid process [5]; this issue has been a subject of a review [6]. Some techniques lead to the simplest spherical or polyhedral shapes, some others are used to get forms of high geometrical and morphological complexity. The complexity involves both, the geometry of the hierarchical structures (fractals, arrays, superlattices, complexes...) and their building blocks such as nanocapsules, nanoboxes, necklaces, nanoflowers, nanochains, dendrites, multipods, etc. Such unusual forms include, for example, disordered pyramidal pits (‘negative pyramids’) [7] and hedgehog-like nanocrystals of complex geometrical and chemical nature [8].

Computational approaches are under development aiming for prediction or explanation of the nanocrystal shape and morphology (see, e.g., ref. [9]). Almost twenty simple experimentally found shapes have been distinguished for metallic nanocrystals [10]. The existing shape classification schemes can become a basis for a more detailed shape and morphology classification and analysis.

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